Investigation of Hungarian Early Copper Age Settlements through Magnetic Prospection and Soil Phosphate Techniques

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Abstract. Vertical magnetic gradient measurements and soil phosphate analysis were employed for mapping the subsurface architectural characteristics of two Early Copper Age settlements at Vésztő-Bikeri, SE. Hungary. The geophysical investigations were part of a larger excavation campaign, the Körös Regional Archaeological Project, which is focused in the study of settlement organization, land use, and subsistence in the Neolithic-Copper Age transition on the Great Hungarian Plain.

Ground prospection techniques covered two hill settlements, Vésztő-20 and Kőrösladány-14, separated by a small creek running along the boundaries of the sites. The results of the magnetic survey defined the extent and layout of the structures and features across the settlements. Excavations at the site Vésztő-20, following the geophysical survey, verified most of the geophysical targets, such as wall trenches, ditches, pits, and a system of concentric ditches enclosing the site. The soil chemical survey recorded high concentrations of phosphate around the perimeter of the site (near the circular enclosures). Test excavations confirmed that some of these high phosphate concentrations are associated with middens. Similar features were also identified at the hill of Kőrösladány-14, suggesting a pattern for the architectural planning of Early Copper Age agricultural settlements.

Keywords: Hungary, Copper Age, geophysics, magnetic survey, soil phosphate analysis

1. The Vésztő and Kőrösladány – Bikeri Sites

The site of Vésztő-Bikeri (Vésztő 20) is located just south of the well-known tell site of Vésztő-Mágor (Bognár-Kutzián 1972; Hegedűs, and Makkay 1987). Vésztő-Bikeri sits on a low hill overlooking an old channel of the Körös River near the modern town of Vésztő, Hungary. Across the channel, to the west, lies the second hill of Kőrösladány-Bikeri (Kőrösladány 14) (Ecsedy, et al. 1982, Parkinson et al. 2004). The surface material at both settlements retained their spatial integrity, suggesting that sub-surface features remained intact (Parkinson et al. 2002), unlike most shallow Tiszapolgár settlements where cultural deposits were destroyed by modern plowing.

Since 2000, large block excavations in the central area of Vésztő 20 uncovered the dirt floors of wattle-and-daub structures which had been burned and levelled by the Tiszapolgár inhabitants. They are marked by layers of daub fragments in a clay matrix overlying a thin clayey silt “floor” deposit that contains small flecks of burnt daub, ECA ceramics, burnt bone, lithic artifacts, and flecks of charcoal. With the exception of an intrusive Hungarian Conquest period burial (10th century AD), all material associated with the structures dates to the ECA Tiszapolgár Culture (Parkinson et al 2002).

In 2001, the archaeological team excavated two 2x2 m test units at Kőrösladány 14, which produced some Early Copper Age materials (ceramics, animal bone, etc.), but no clearly defined cultural layers or features, as at Vésztő 20. Rather, the material was spread in a general ‘sheet midden’ throughout both test units.

2. Magnetic and Soil Phosphate Techniques

In order to investigate further the form and extent of the wattle-and-daub structures and the location and layout of features associated with the structures, magnetic and soil chemistry surveys were undertaken in both settlements in order to locate and map all of the structures, features, and activity areas at both settlements.

A high-resolution (0.25–0.5 m sampling interval) magnetic survey covering over 5,000 square meters of the area surrounding the central excavation blocks was conducted in 2002 at Vésztő 20 (Sarris et al, 2004). The magnetic survey expanded the following year at the site of Kőrösladány 14, covering an area of 5,600 square meters. A Geoscan FM36 fluxgate gradiometer was employed during the investigations. Selective de-spiking techniques were used to isolate the extreme values that masked the anomalies of interest. Kriging interpolation was used for gridding the data. Line equalization techniques in both 1 and 2 dimensions were used for the rectification of the data to the 0-level base line. This step was crucial in cases where data were suffered by instrumental or geological drift. Selective compression of the dynamic range of values was also employed to isolate anomalies close to the

background level. High-pass (gradient) filters and the calculation of first horizontal derivatives helped emphasize the high frequency components of the geophysical maps. Interpretation maps were made based on the features that were identified as the data were processed.

Similarly, an Oakfield soil probe was used to collect soil samples at 10m intervals within a 9400 square-meter grid at the centre of Vésztő 20 and from transects extending 100m east and 100m south of the site. These samples were analyzed for phosphate levels and the results provided information on site activities and organization that complemented the results of the magnetic survey. The quantifiable colorimetric analysis of available phosphorus content in each soil sample was accomplished using a modification of the methods outlined by Murphy and Riley.

3. Vésztő 20

Among the most prominent features, which were identified through the magnetic survey at Vésztő 20, are two circular rings, found to encircle the settlement enclosing a dense cluster of structural remains (Fig. 1). The geophysical "signature" of the circular enclosures indicated that they were concentric ditches, with diameter approximately 65m and 75m for the inner and outer ditch correspondingly. The non-uniform magnetic signature of these circular features suggested that there were postholes within the trenches. The inner ditch was better defined, probably because it was deeper. The rings were verified through ground-truthing techniques on the north and northeast edges of the site. Excavations confirmed that the inner and outer ditches were located exactly where they were mapped during the geophysical survey. As predicted, several postholes were exposed within the inner, deeper ditch. In the two long excavation trenches, segments of this inner ditch were 0.8m wide and extended up to 1.3 m below the present surface, and as much as 0.65 m below the base of the plow zone. The postholes within the inner ditch range in diameter from 0.2 to 0.3 m and extend another 0.5 m beneath the bottom of the trenches (1.55–1.8 m below the surface). A third, narrow, shallow ditch was exposed midway between the inner and outer ditches. The latter was not able to register to the magnetic data, mainly due to its small size and the absence of artefacts or burned daub in its interior. Radiocarbon assays on charcoal in the ditches date to the Early Copper Age and are contemporary with other 14C dates from the site. While the ditches seem to encircle the settlement, their magnetic signal is weaker in the west and southwest where they may have been partly eroded through cultivation or periodic flooding of the channel, which flows nearby.

The centre of the settlement shows a number of rectangular features, probably associated to habitation units. They are aligned in an almost north to south direction, although some deviations are noticed, probably due to the slope of the mount. None of the linear features mapped by the magnetometer survey overlap, and excavations suggest that the structures at Vésztő-Bikeri were built and used at roughly the same time.

At the edges of the cluster of the houses, a few isolated

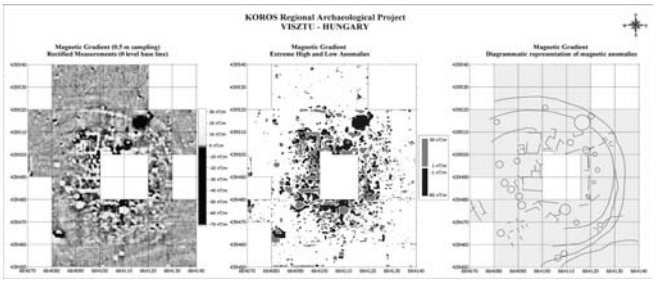

Fig. 1. Magnetic survey at Vésztő 20. Processed data (left), extreme high and low values of the vertical magnetic gradient (center) and diagrammatic interpretation of the geomagnetic features (right).

anomalies have been identified, some of which are related to the existence of kilns, fire hearths and pits. The density of the magnetic features falls substantially in the area between the inner ditch and the pits (to the south and west) or between the inner ditch and the houses (to the north), suggesting that only part of the settlement was used for habitation, permitting other activities (keeping animals and dumping trash) within the site.

In order to verify the different usage of space within the settlement, soil phosphate measurements were conducted in soil samples collected from within and outside the limits of the site (Billingsley and Galaty 2003). High phosphorus levels were located at the perimeter of the site, while lower levels were measured in the central area of the site. This pattern fits the model for agricultural settlements where residents removed organic waste from living quarters and deposited their trash in "ring middens" at the perimeter of the site. The low phosphorus levels in the area near the structures also seem to indicate that organic waste was not a constituent of the daub employed in the manufacture of the buildings at Vésztő 20. On the other hand, higher levels of phosphorus were recorded in the area where possible kilns, ovens, pits, or hearths were mapped during the magnetic survey, caused probably by residues of organic material used in cooking and food storage processes.

4. Kőrösladány 14

The continuation of the magnetometry prospection survey to the Early Copper Age (Tiszapolgar) settlement of Kőrösladány-Bikery (Kőrösladány 14) provided useful information regarding the settlement structure, complementary to the data collected from Vésztő 20 in 2002.

Similarly to Vésztő 20, Kőrösladány 14 seems to consist of three concentric circular rings, found to encircle the settlement enclosing a dense cluster of structural remains, most of which however do not register clearly in the magnetic measurements (Figs. 2–3). The rings may be identified with foundation trenches for wattle and daub palisades, as it is suggested by the non-uniform signal originating from the ditches. The middle trench is the most prominent one, having a 50m diameter and 2–2.5 m width. The inner trench lies about 4–5 m from the middle one, while the outer ditch has a diameter of 70 m. Thus, the area of the settlement is very similar to that of Vésztő 20.

The fading signal of the circular ditches to the eastern parts of Kőrösladány 14 is in agreement with the similar tendency

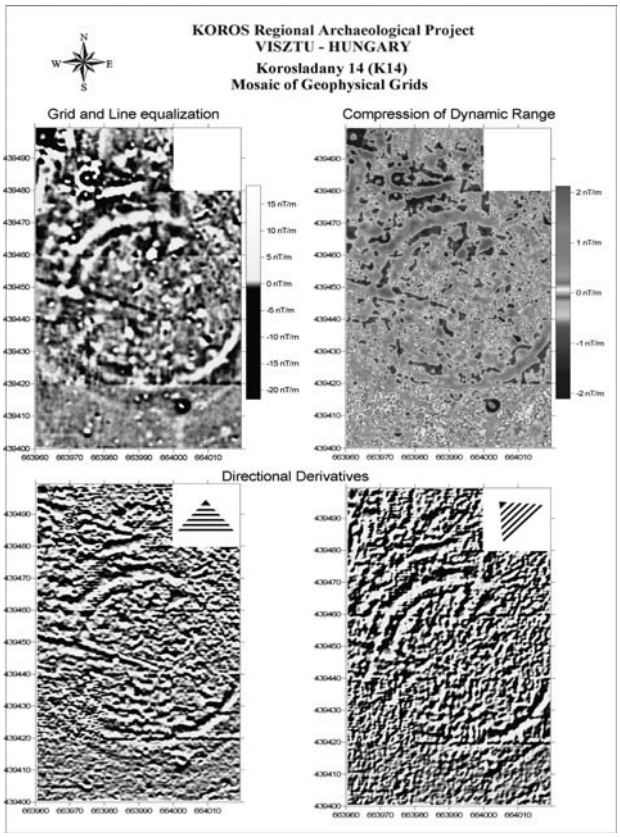

Fig. 2. Magnetic survey at Kőrösladány 14. Processing of the raw data with grid and line equalization techniques (upper left), compression of the original dynamic range of the vertical magnetic gradient values (upper right) and application of directional derivatives (lower images).

noticed towards the west and south-west edges of Vésztő 20, intensifying the hypothesis that the ditches of both settlements may have been eroded due to the flooding episodes of the near-by channel.

A 38m long linear anomaly crossing the eastern section of Kőrösladány 14 may be identified with a path leading away from the settlement. The intersection of it with the ditches also suggests remnants of the main entrance to the settlement.

The interior of the settlement shows evidence of pits and small structural remains, most of which have dimensions of less than 5x3m. The structures are not clearly defined as it was the case with Vésztő 20. This may suggest an absence (or at least smaller intensity) of fire incidences at the final stages of the settlement. Finally, a few widespread high intensity anomalies at the northern section of the settlement (Fig. 4) may be related to workshop activities (pits, kilns, etc). In contrast to Vésztő 20, there is no evidence of a distinct house clustering or differentiation of area usage due to the spatial density of the architectural relics.

5. Final Remarks

The identification of the architectural features and the different usage areas through the employment of geophysical prospection and soil chemical analysis has enhanced our understanding of the layout and organization at small

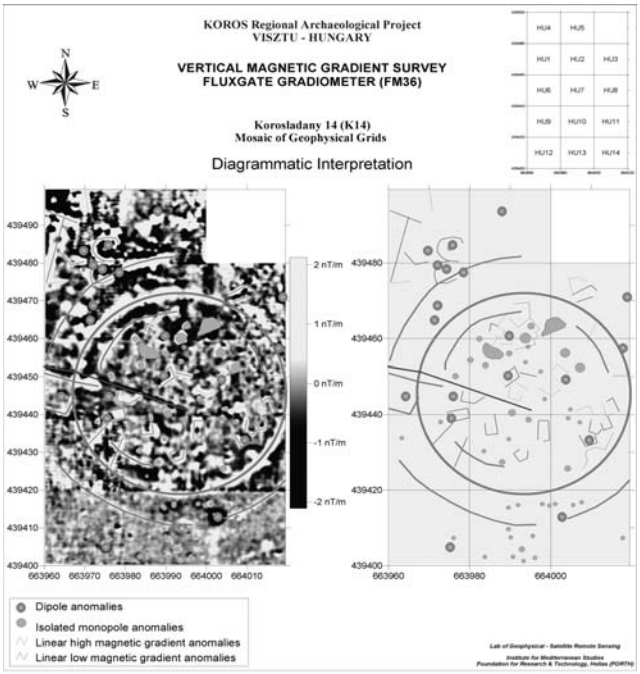

Fig. 3. Diagrammatic interpretation of the vertical magnetic gradient anomalies at Kőrösladány 14.

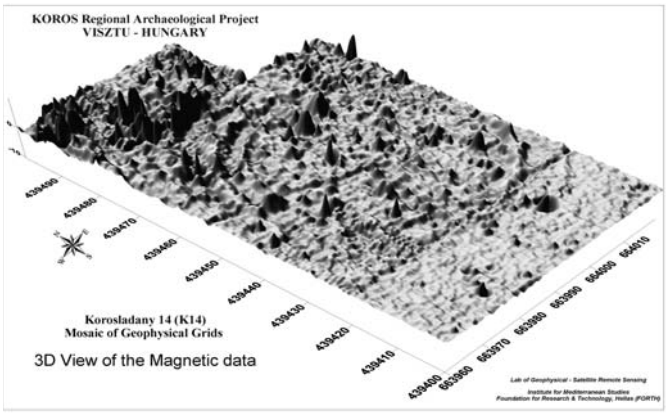

Fig. 4. 3-dimensional representation of the magnetic anomalies at Kőrösladány 14.

dispersed Tiszapolgár agricultural settlements. The above techniques were able to outline the boundaries of the sites and provide an estimate of the number and distribution of the structural remains.

At the Vésztő-Bikeri site, a central cluster of 10 or 12 wall trench compounds and structures made of wattle-and-daub are flanked on the east and west by kilns, ovens, hearths and pits. An open space separates this central living area from a midden ring or dumping zone that is enclosed by a triple ring of concentric ditches and palisades. This type of distinction is not evident at Kőrösladány, although both settlements are encircled by a system of 3 concentric circular ditches, probably related to foundation trenches for wattle and daub palisades. The triple enclosures around the settlements come in contradiction to the current theories which suggested a medium of peaceful conditions across the Great Hungarian Plain during the Early Copper Age.

Remote sensing and excavation data suggest that the households at the large Late Neolithic sites become separate

Early Copper Age sites. Further work in the area is under process, aiming to create a model of ECA settlement organization and employ it in our ongoing studies of the Neolithic-Copper Age transition on the Great Hungarian Plain (circa 4,500 BC.).

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